



# ***Fluids and Combustion Facility Preliminary Design Review***



# **Steady State Integration & Operations**

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February 12, 2001

## **Exhibit 2**

*DO-02 Telescience Support Center Development, Implementation & Operations*

*DO-17 FCF Mockup Upgrades and Development*

*DO-26 Payload Rack Checkout Unit Operations (Ground Segment)*

*DO-28 (DO-01) Mission Integration and Planning*

*DO-31 (DO-21) Engineering Integration (Payload to FCF)*



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## **Steady State Integration and Operations**

- Exhibit 2 Scope
- Intra-Contractual Relationships
- Near Term Payload Support
- Payload Interfaces
- Mission Integration & Planning Process
- Ground Processing
- Training
- Operations
- Current Status
- Future Work

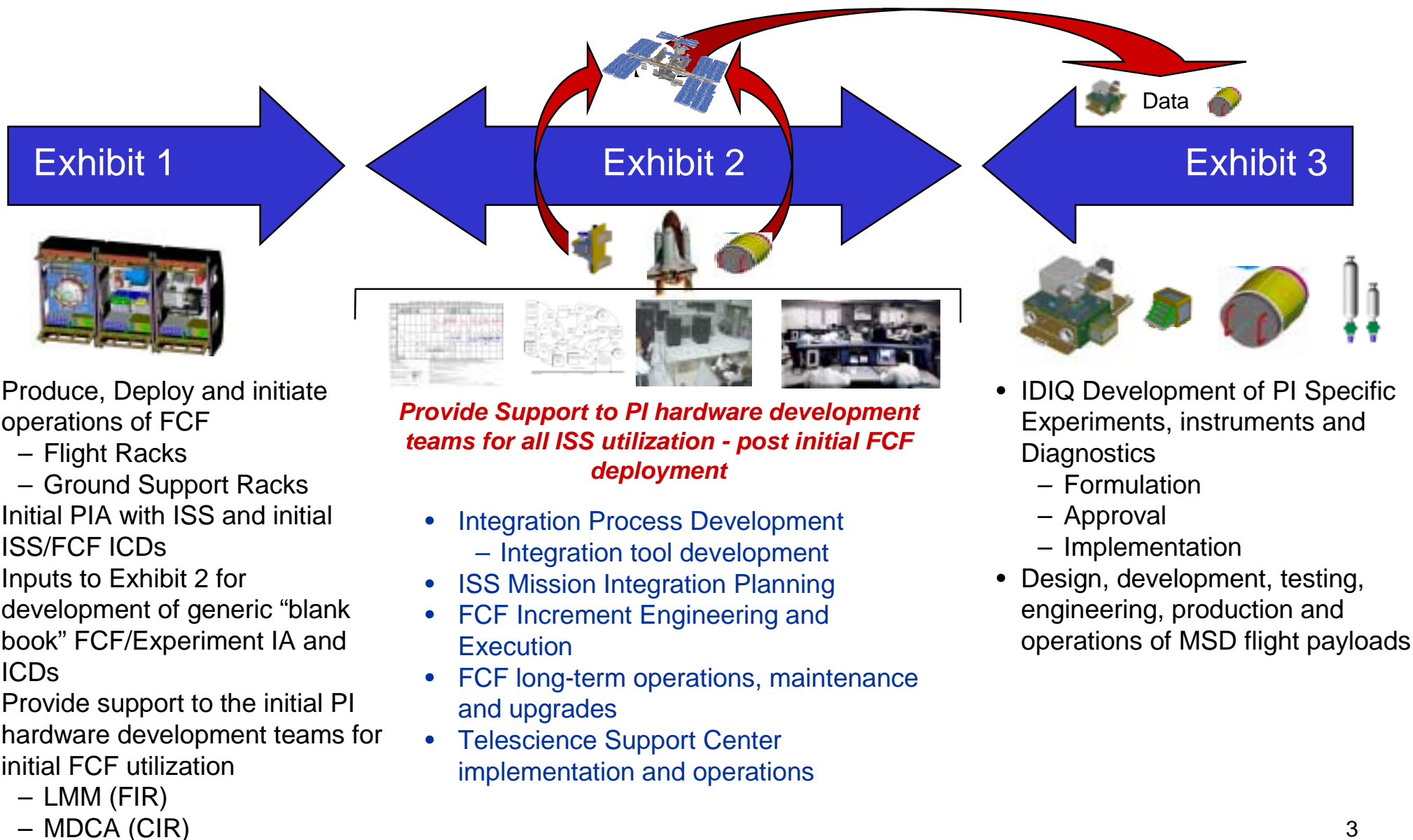


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### MRDOC Exhibit 2 Scope



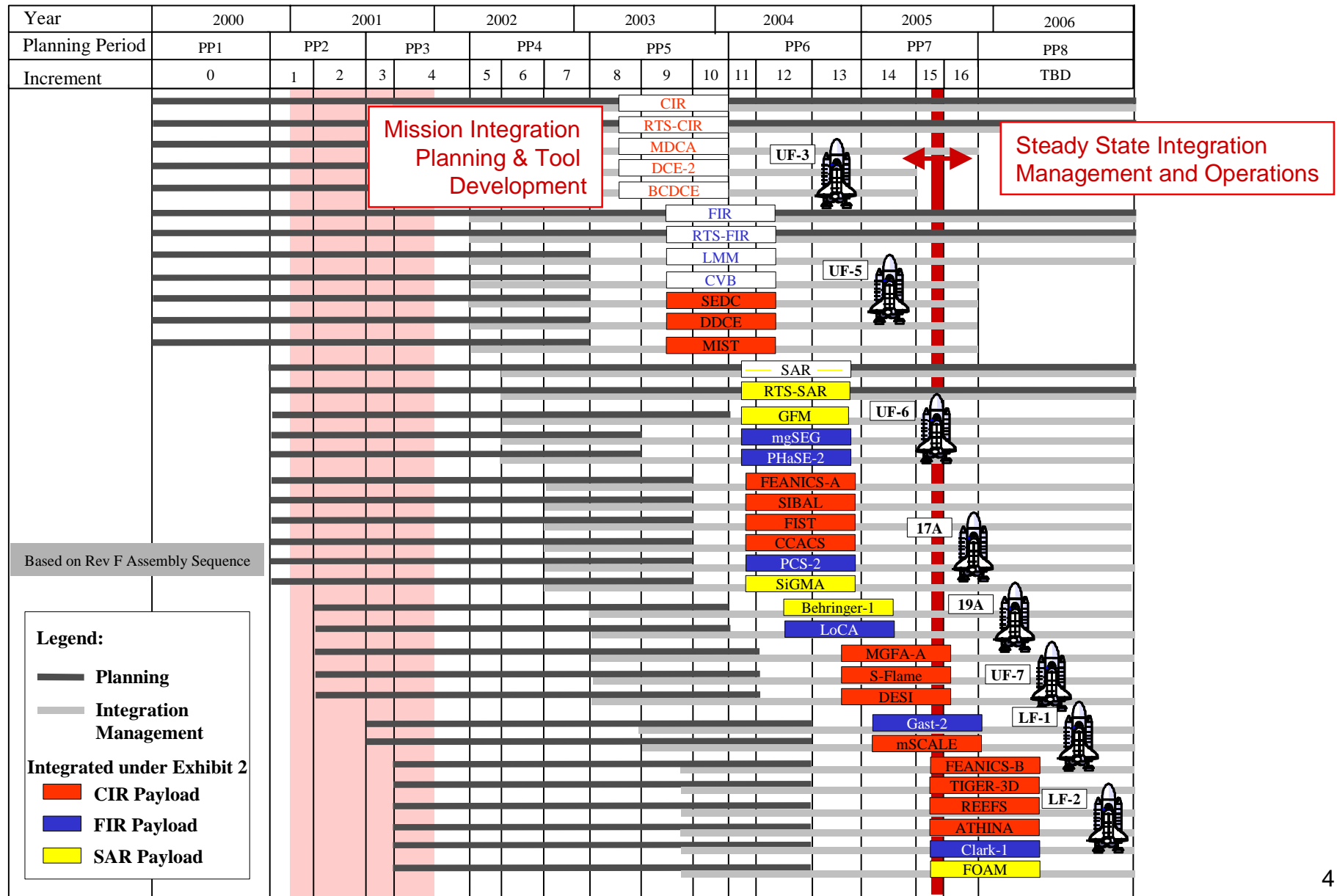


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### FCF Payload Planning and Integration Timeline -> 2006



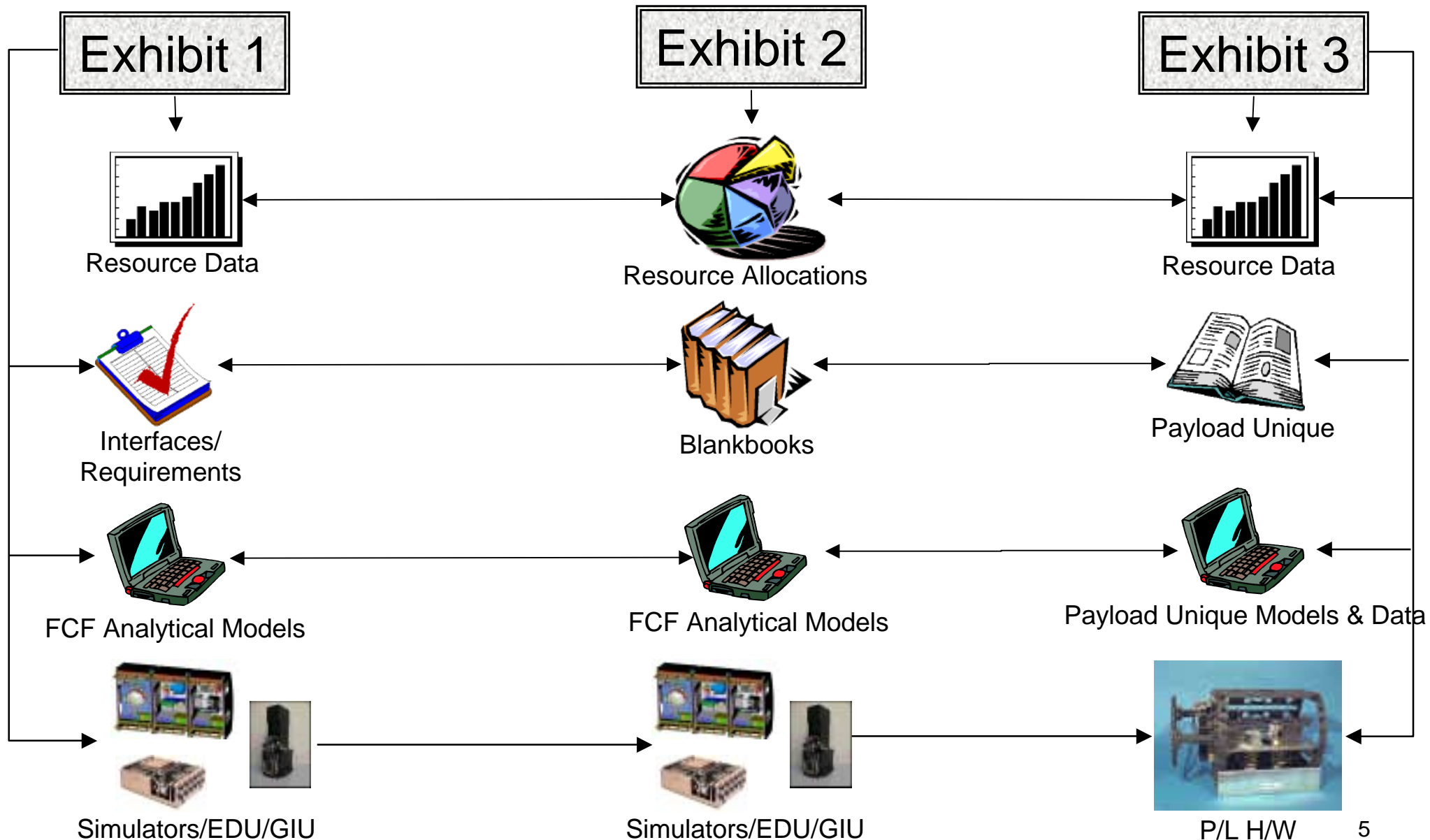


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### Intra-Contractual Relationships





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### **Intra-Contractual Relationships**

- **Near term responsibilities require significant work between MRDOC contract exhibits**
  - Sharing of information
  - Usage of deliverables
- **Exhibit 1 to Exhibit 2**
  - Exhibit 1 develops interfaces and requirements for payloads and Exhibit 2 converts to Interface Control and Verification documentation
  - Exhibit 1 provides analytical models for FCF verification and payload rollup analysis
  - Exhibit 2 provides documentation for use by Exhibit 1 (if required)
  - Exhibit 2 provides ISS resource validation through payload planning
  - Exhibit 2 provides operation and maintenance of Exhibit 1 provided simulators
- **Exhibit 2 to Exhibit 3**
  - Exhibit 2 provides programmatic, interface and verification documentation to payloads for development of payload unique documentation
  - Exhibit 2 provides guidance in payload unique documents as required
  - Exhibit 2 provides simulators for Exhibit 3 use
  - Exhibit 3 provides payload resource data for incorporation into payload database by Exhibit 2
  - Exhibit 3 provides data and payload unique analytical models for FCF rollup analysis



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## **Near-Term Payload Support**

- Increment and Integration Management/Operations for initial payloads provided by Exhibit 1 through initial science operability
- Exhibit 2 acceptance of racks and initial multi-user facilities (MDCA and LMM) after initial science operability (Handover from Exhibit 1)
  - SAR handover after payload or intra-facility operability complete
  - Exhibit 2 rack ownership includes interfaces with the ISS
- Methods to ensure seamless transition of racks/payloads:
  - Involvement in development of interface, verification safety and configuration documentation
  - Participant in rack-payload integration teams
  - Involvement in initial payload operations
- Handover of GIU to occur after completion of acceptance testing (L+TBD)
- Handover of EDU is TBD pending ground segment throughput analysis
  - Usage required prior to flight rack handover to accommodate following increments as shown in the FCF Payload Planning and Integration Timeline



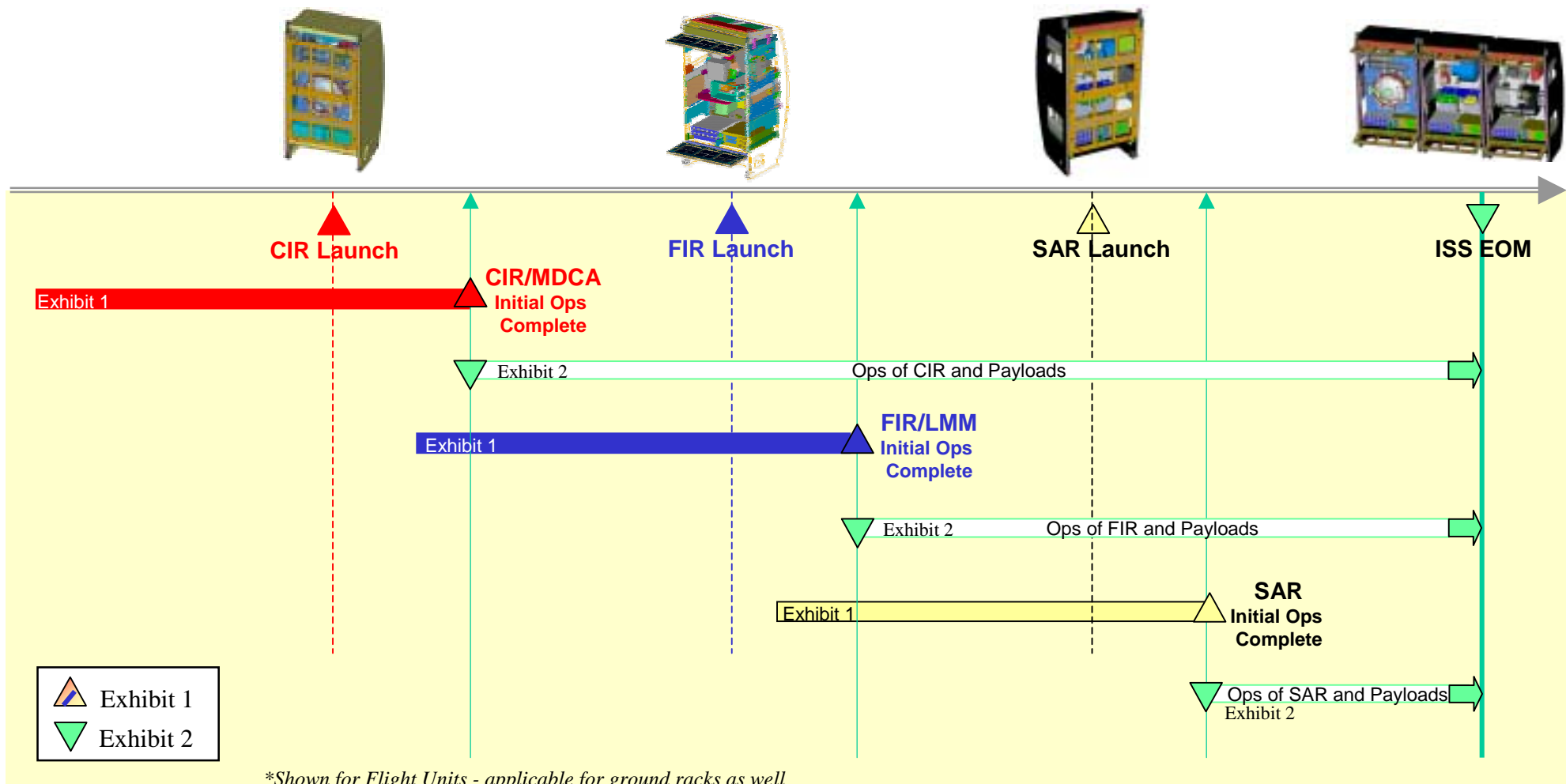


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### Near-Term Payload Support (Flight Units)





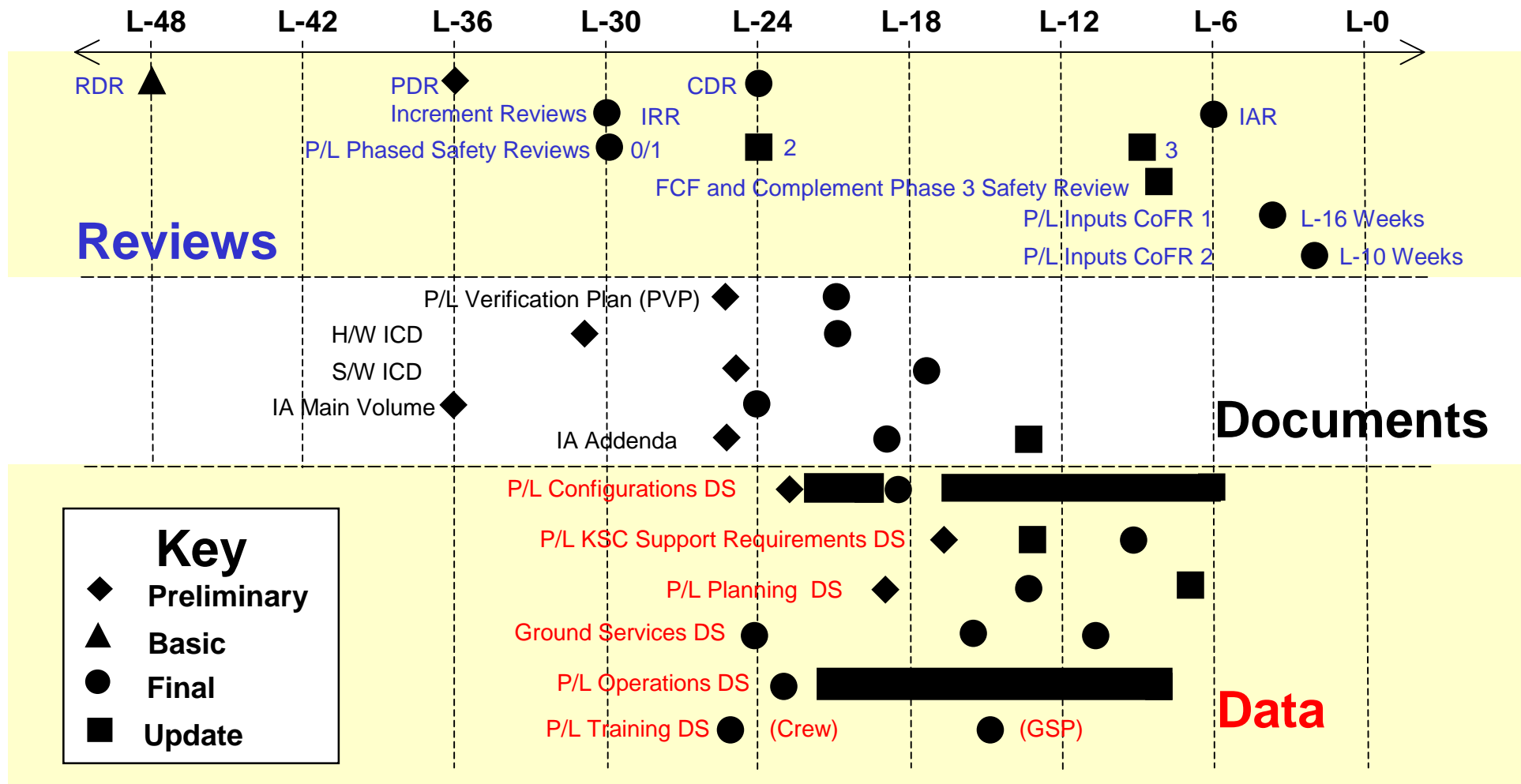


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### Mission Integration & Planning (MIP) Process Milestones



\* Detailed processes and deliverables are provided to the individual payloads in the End-to-End Planning and Integration Process Definition Document MIP-DOC-0002

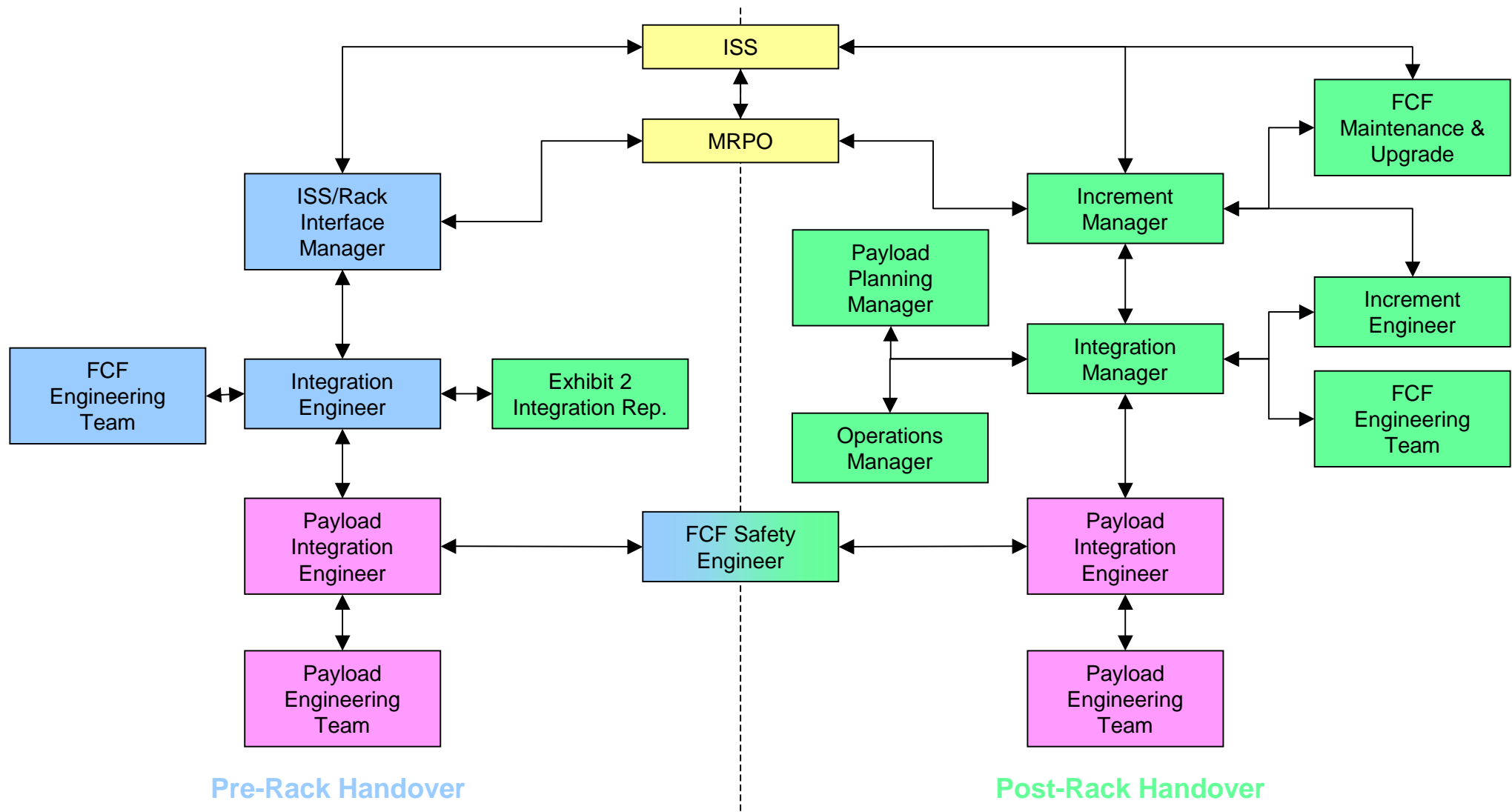


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### Payload Interfaces





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### **Mission Integration & Planning (MIP) Process Summary**

- Conduct Kick-off meetings with new payloads
- Collect payload data for planning and integration
- Submit increment and multi-increment FCF rack-level data to MRPO
- Maintain GRC/MSD ISS Utilization Traffic Model
- Develop/maintain FCF-to-PL integration documents
- Submit FCF rack-level and payload complement data to Payload Data Library (PDL) per increment
- Perform Increment Reviews for FCF and payload complements and conduct integration TIMs
- Support payload engineering integration activities
- Support pre-launch GRC and KSC ground processing and post-landing activities
- Develop and maintain MSD ISS Utilization Website



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## **Payload Kick-Off Meeting**

- The Kick-off meeting occurs after a new payload is identified by NASA GRC MSD
- At the Kick-off meeting the following information is provided to the payload:
  - MIP process overview
  - Payload Accommodations Handbook
  - Interface Definition Document
  - Integration Agreement Blank Book
  - Generic Payload Verification Plan
  - MIP point of contact



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### **Collect Payload Data**

- Provide web-based forms for payload data entry
- Payload developer enters data after the Kick-off meeting and subsequently at each major project review (RDR, PDR, CDR, etc.)
- Data can be viewed and entered over multiple sessions
- Once data submitted, the MIP team validates the data and maintains it under configuration control
- Payload planning data collected includes (Details on following slide):
  - Multi-increment dataset
  - Increment data
- Increment payload data includes data required by the Integration Agreement (IA) Data Set Blank Book



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### GRC/MSD ISS Utilization Traffic Model Maintenance

Preparation of drafts for recommended changes to MSD Management Team (MMT)

- Validation of traffic model against ISS resources
- Identifies all payloads where planning data is collected and maintained

GRC/MSD ISS Utilization Traffic Model Draft (January 2001)

Rev. F	Apr-01	Feb-02	Jun-02	Feb-03	Jun-03	Sep-04	Feb-05	Jun-05	Oct-05	Jan-06	Apr-06	Jul-06	Oct-06	Feb-07	May-07	Jul-07
PP	2	3	4	5	5	6	7	7	7	8	8	TBD	TBD	TBD	TBD	TBD
Increment	2	4	6	8	9	13	14	15	16	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Flight	6A <sup>1</sup>	UF-2 <sup>1</sup>	ULF-1 <sup>1</sup>	12A.1	13A.1	UF-3 <sup>1</sup>	UF-5 <sup>1</sup>	UF-6 <sup>1</sup>	17A <sup>1</sup>	19A <sup>1</sup>	UF-7	LF-1 <sup>1</sup>	LF-2 <sup>1</sup>	LF-4 <sup>1</sup>	LF-5 <sup>1</sup>	LF-6 <sup>1</sup>
Facilities	ER <sup>1</sup> ER <sup>2</sup> ARBS	MSG ER <sup>3</sup> ARBS				CIR ARBS	ER <sup>6</sup> ER <sup>7</sup> FIR ARBS	ER <sup>8</sup> SAR ARBS								
Combustion Science Payloads						DCE-2 BDCCE	SEDC DDCE DCE-2 BDCCE		SIBAL FIST SEDC DDCE	OS-FLAME DESNI SIBAL FIST		TYGER-3D REEFS ATHINA OS-FLAME DESNI		V-FLAME PUFF TYGER-3D REEFS ATHINA		
Non-GRC Payloads							MIST <sup>1</sup>		CCACS <sup>1</sup> MIST <sup>1</sup>			CCACS <sup>1</sup>		Turba <sup>5</sup>		Turba <sup>5</sup>
Fluid Physics Payloads	PCS-ER <sup>2</sup> <sup>1</sup> PCS-ER <sup>2</sup> <sup>1</sup>	PCS-ER <sup>2</sup> <sup>1</sup> PCS-ER <sup>2</sup> <sup>1</sup>				MIDAS <sup>5</sup>	CVB	PHASE-2 SEG MIDAS <sup>5</sup> CVB	PCS-2 SIGMA SEG	LOC Banger-1 PHASE-2	PCS-2 SIGMA Banger-1	Gas-2 msCALE LOC	Clak-1 FOAM Gas-2	MOBI NBX Clak-1 msCALE	Stee-1 CRWT FOAM	Dhr-2 Raf-1
Acceleration Measurement Payloads						PTS-CIR	PTS-FIR	PTS-SAR								
MSG-PI			CSLM-2 <sup>1</sup> <sup>6</sup> CSLM-2 <sup>1</sup> <sup>6</sup>		Gas-1 <sup>6</sup>	Kim-1 <sup>6</sup> Gas-1 <sup>6</sup>	Manda-1 <sup>6</sup> Kim-1 <sup>6</sup>	EGM <sup>6</sup> Urban-1 <sup>6</sup>	Manda-1 <sup>6</sup>	Marion-1 <sup>6</sup> EGM <sup>6</sup> Urban-1 <sup>6</sup>			Marion-1 <sup>6</sup>			

Legend: (Upmass-Filled; Downmass-Empty)

Facility	Discipline
CIR	Combustion Science
FIR	Fluid Physics
SAR	Acceleration Measurement
MSG-PI	Materials Science
ER	



GRC Microgravity Science Division Chief : **Draft (01/01)**

Rev. F Assembly Sequence - SSCB approved, 08/24/00



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### **Increment and Multi-increment Data Submittals**

- Payload planning data is collected and maintained in a database for all payloads identified on the GRC/MSD ISS Utilization Traffic Model:
  - **Administrative:** Payload name, acronym, ISS sponsor developer
  - **Operations:** Typical run time, crew time per run, on-orbit placement
  - **Hardware:** Container type, location, mass volume, late access, early access, Middeck transportation required
  - **Power:** Typical, peak, minimum continuous powers and durations, up/down transportation power, cooling requirements (air and liquid)
  - **Data&Video:** Typical and peak downlink/uplink and durations, ISS video, HRL, 1553 data, Ethernet
  - **Fluids:** Nitrogen, argon, carbon dioxide, helium, vacuum vent, vacuum resource
  - **Logistics:** Resupply and return mass and volume per run
  - **On-orbit Stowage:** Passive, waste and other volumes per run
  - **Microgravity:** ARIS, disturbance sources
  - **Flights:** Stage Flight, runs per stage, transportation location, on-orbit location
- Data is electronically submitted annually to MRPO at FCF rack-level for FCF payloads at PP-54, PP-42 and PP-30





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### **FCF to Payload Integration Documentation**

- Integration Agreements (IA) including Main Volume and increment specific Addendum
  - Sub-rack payload Integration Agreement (IA) Blank Book
  - Sub-rack payload level IA
  - Payload Unique Integration Schedule
- Data Sets (Payload Data Library)
  - FCF rack-level data set for each increment
  - Sub-rack payload data sets for each increment
- Interface Definition Documents (CIR, FIR and SAR)
- Interface Control Documents (sub-rack payload)
- Generic Payload Verification Plan (CIR, FIR and SAR)
- Sub-rack payload-unique Verification Plans

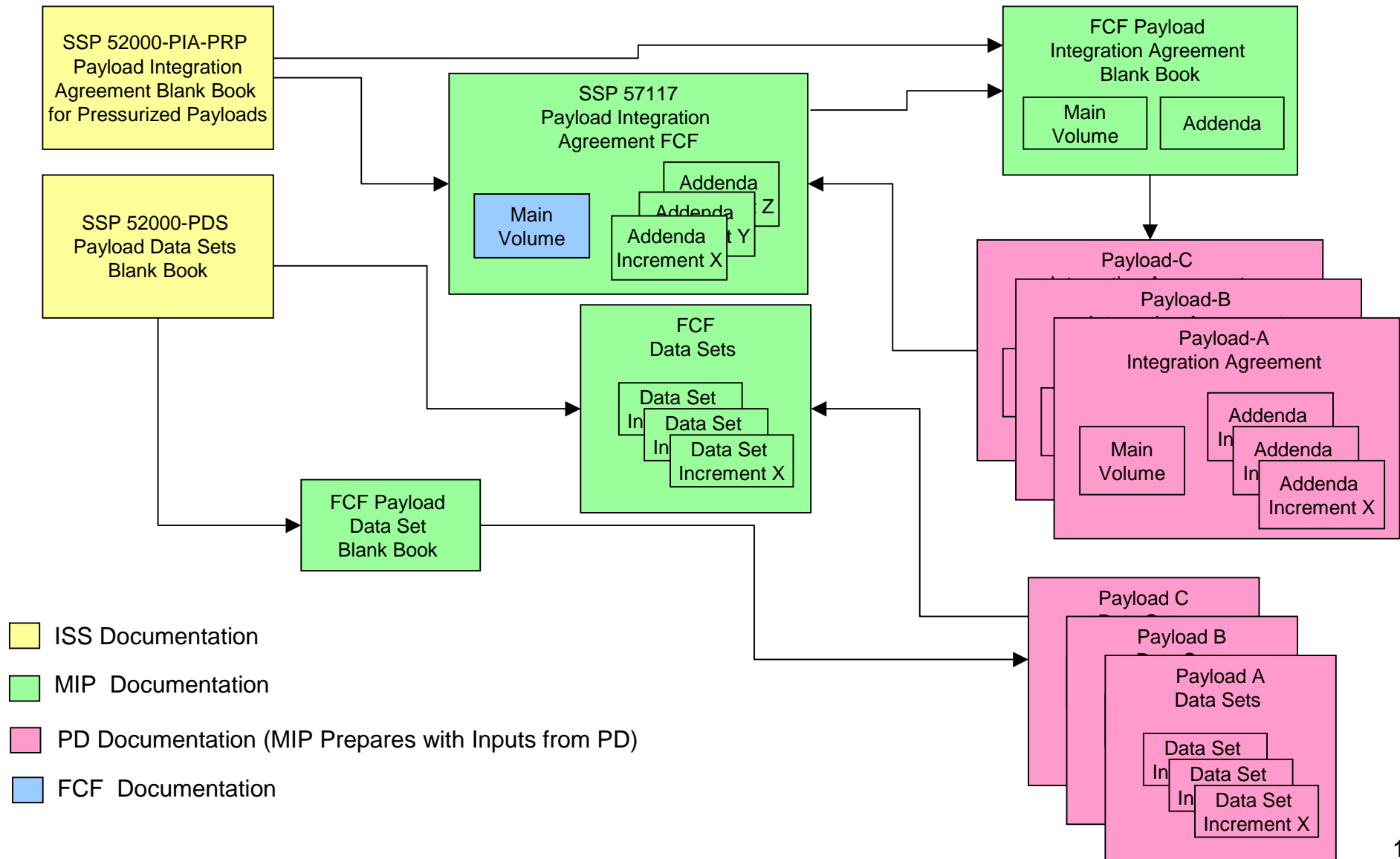


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### Integration Agreement Documents



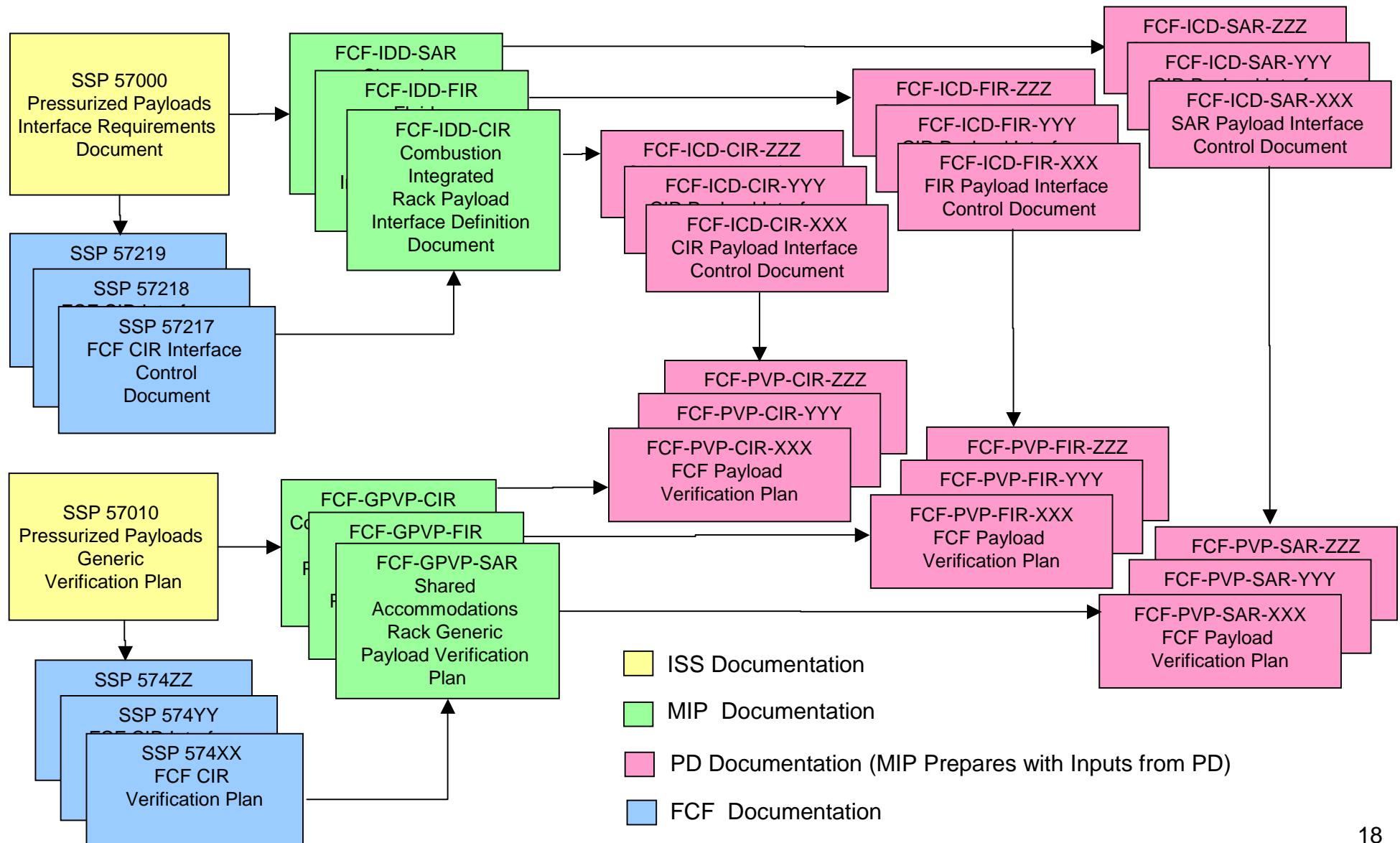


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### Interface Control and Verification Documents



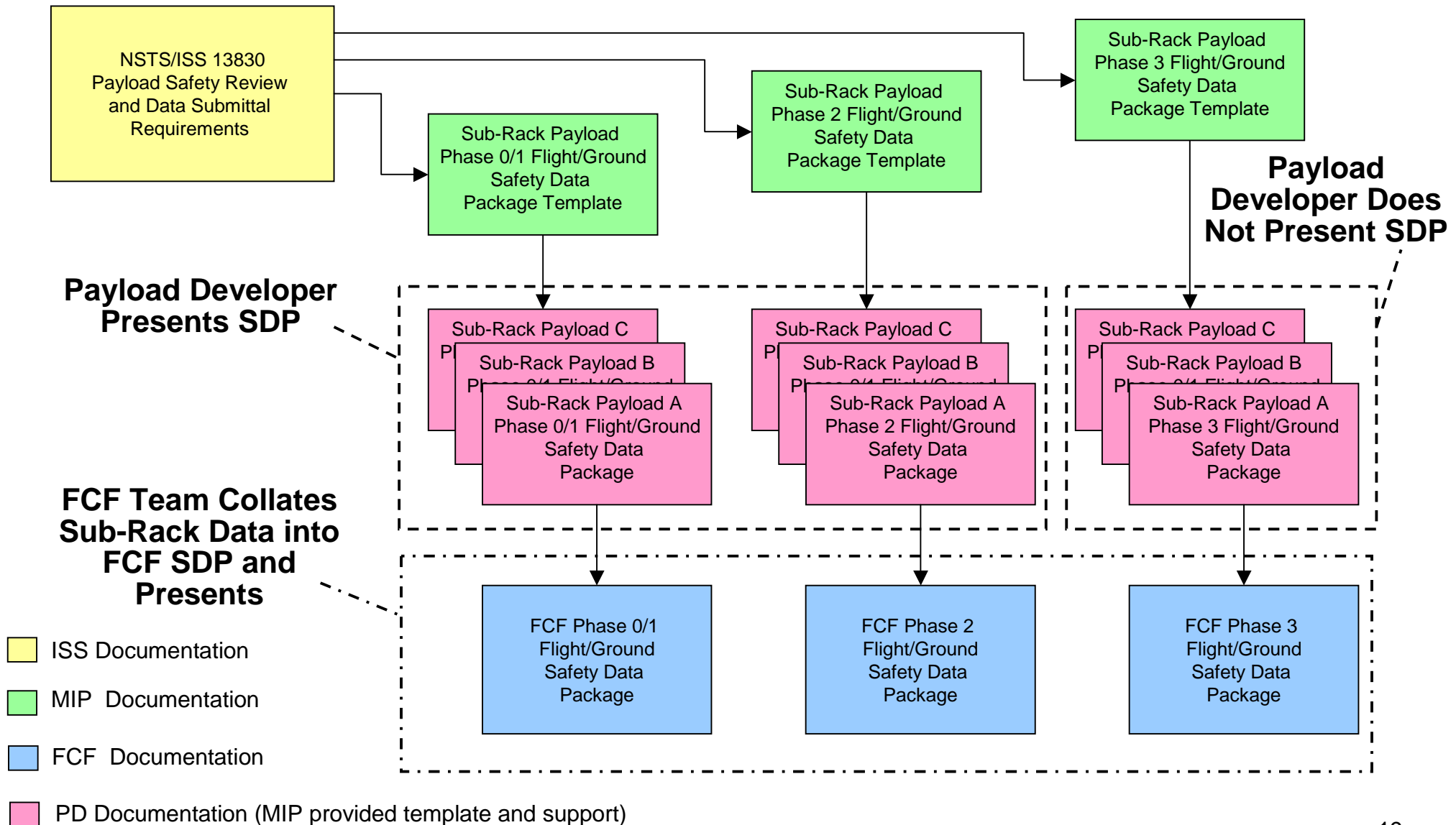


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### Safety Documents





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## **Increment Data Set Submittals**

- The MIP team works with individual sub-rack payloads to assist them in preparing payload-unique data sets:
  - Command & Data Handling
  - Configuration
  - Ground Data Services
  - KSC Support
  - KSC Technical
  - Operations
  - Training
- MIP team performs increment analysis to provide roll-up (i.e., summations, timelines, etc.) of data to FCF rack-level and electronically submits data to Payload Data Library (PDL)



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## **FCF Increment Reviews**

- **Increment Requirements Review**
  - Provide an overview of the specific increment to all payloads involved in increment
  - Identify ISS and FCF resource issues that surface during the development of the payload-unique PVPs and ICDs
- **Increment Acceptance Review**
  - Provide an overview of the specific increment
  - Review FCF rack verification package and verify all issues and payload endorsements are resolved
  - Resolve any FCF Phase III safety review issues
  - Provide summary of compliance with ISS and FCF resources



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### **Ground Processing**

Ground processing of payloads begins with delivery of simulators through handover to KSC for stowage

- Component/ORU Simulators provided to assist payload in experiment development during conceptual and final design phases
- Engineering model (becomes the EDU) made available as requested to allow payloads more readily available access to FCF-like interfaces
- Experiment Development Unit (EDU) and Ground Integration Unit (GIU) maintained for testing of payload hardware at GRC
- Payloads are required, at a minimum, to perform functional check with the GIU prior to shipment to KSC for launch
  - Serves as final interface verification
  - Completes both FCF and ISS level verification closure items
- KSC processing for payload hardware limited to off-line labs (i.e. No FCF rack simulators available at KSC)
- GIU also made available to payloads for on-orbit troubleshooting





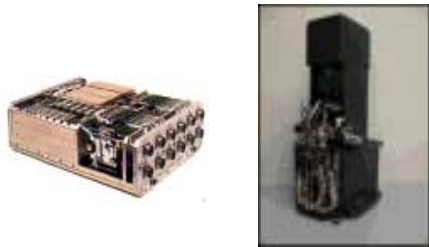
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### Ground Processing

FCF



- Simulators
  - Component
  - Diagnostic



- Experiment Design Unit



- Ground Integration Unit
  - Final Verification



- KSC Off-line Processing

- Trial Hardware
  - Brassboard
  - Breadboard



- Engineering Model



- Flight Unit



- Final Flight Preparations



Payload Developer



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### **Training**

- Training data for individual payloads is rolled up into single rack/facility submittal
- Crew training of payload hardware is conducted by the payload with FCF support
  - Payload provided with simulator requirements
  - Training conducted in FCF simulator at JSC
- Payload participates in ongoing FCF Training Strategy Team (TST) process
- Payload is responsible for providing training materials for coordinated submittal to ISS
  - Payload Simulator
  - Payload Operations Training
    - Crew
    - POIC (Payload Operations Integration Center) Cadre
    - GRC TSC Operations Personnel
- Payload participates in training as an FCF team member:
  - 1 - 12 to 9 months Cadre only SIMS. (We use this time for our internal SIMS)
  - 1 - 9 to 6 months Cadre/Payload Developer SIMS
  - 1 - 6 to launch Joint Multi Segment Training (JMST's) (End to End with Crew or backups)



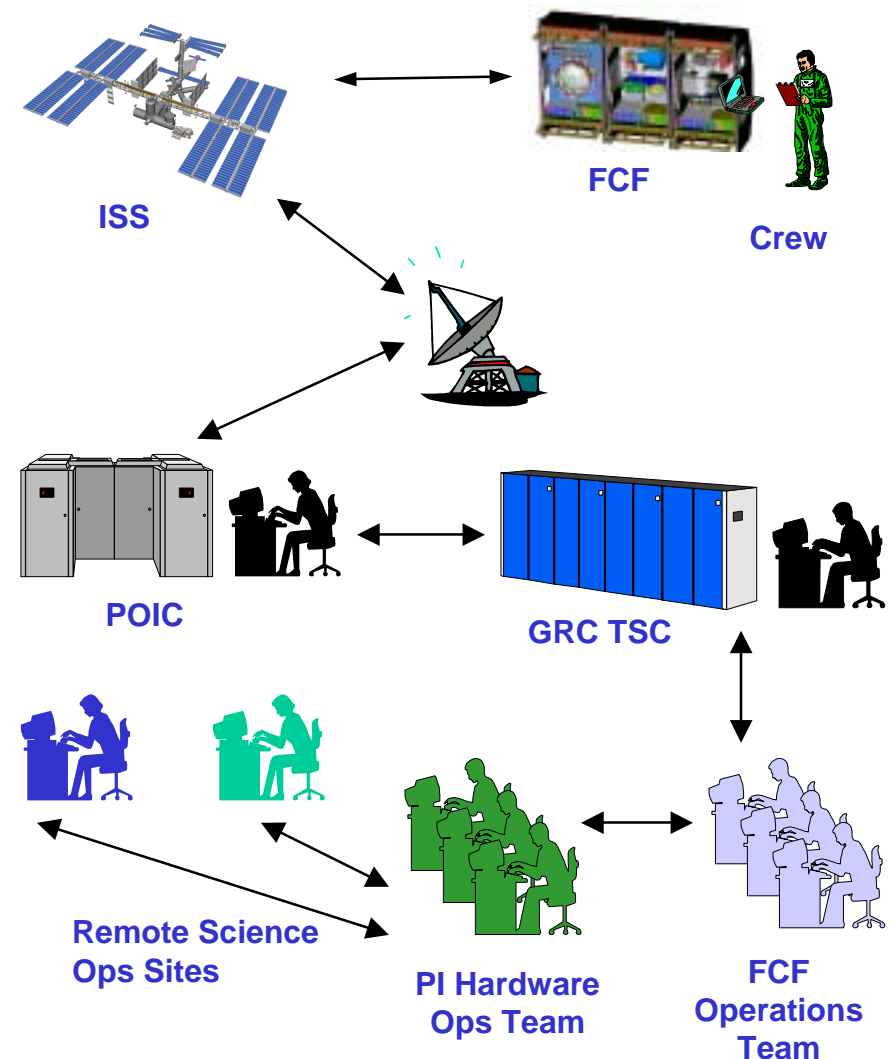
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### Operations

- Payload responsible for input into on-orbit documentation including procedures, flight rules, etc. via operations data set
- Primary ground operations site is the GRC Telescience Support Center (TSC)
- Ops Team is Payload, FCF and TSC personnel
- Payload may command experiment from TSC or remote site
- Experiment progress will be monitored by the Ops teams and the Ops teams will routinely uplink commands based on the experiment protocol
- Operations data for individual payloads is rolled up into single rack/facility submittal
- FCF serves as the integrator of all data submitted to ISS





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### **Telescience Support Center (TSC) Provides**

- **Space and resources for science teams:**
  - Hardware interfaces
  - Training and simulations
- **Facilities - 24 x 7 support for:**
  - Network
  - Data
  - Video
  - Audio
- **IT Services:**
  - Science Data Distribution
  - Data Archival (and playback)
  - Data recording (Video)
  - reconfiguration
  - Remote site setup and support





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### **Current Status**

- Payload Planning
  - Planning Data Collected for All Payloads
  - First Analysis of ISS Resource Availability against GRC/MSD Utilization Traffic Model Completed
- Integration Documentation
  - Completed Draft Level Documents (IA Main Volume Blank Book, CIR IDD, FIR IDD, CIR GPVP)
  - In-Process Draft Level Documents (IA Addendum Blank Book, Data Set BB)
- Integration Tools: Document Management System Scheduled to be On-line March 1 (Subscriptions, Electronics Signatures, etc.).
- TSC Phase 1 Implementation near completion. Combined Operational Readiness Review (ORR) to be held in February 2001.





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## **Future Work**

- Payload Planning
  - Conduct Kick-off Meetings
  - Continue Collecting Payload Planning Data
  - Continually Adjust Traffic Model Based on ISS Resource Availability Analyses
- Integration Management
  - Intermediate Level Documents (IA Main Volume BB, IA Addendum BB, Data Set BB, CIR IDD, FIR IDD, CIR GPVP, FIR GPVP)
  - Support of Initial Fluids and Combustion Payloads
- Integration Tools
  - Web-based Data Entry for Payload Developers
- TSC Phase II development